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Forest Insect and Disease Management
State and Private Forestry
Region 4 Forest Service
U.S. Department of Agriculture
April 1976

Trends of a Mountain Pine Beetle Outbreak in a High Elevation Stand in Yellowstone National Park

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INTRODUCTION

Three major mountain pine beetle outbreaks in lodgepole pine have occurred in the Intermountain West since the 1920's. In all but one case, loss estimates made during these outbreaks were based solely on personal judgement or opinion. Without definitive mortality information it was difficult to objectively estimate stand losses which led to unreliable and conflicting reports.

During the late 1960's and in the midst of a massive mountain pine beetle outbreak which would eventually cause mortality in most of the lodgepole pine stands in the Intermountain Region, several stands were surveyed during different stages of an outbreak. These data were very valuable but they did not portray the dynamics of an infestation. Realizing the important need to record yearly losses caused by the mountain pine beetle, Parker (1973) initiated a study in a low elevation (6400 feet) stand in the southwest corner of Yellowstone National Park. His purpose was to record the number and size of the trees killed each year from the beginning to the end of an infestation. With the same purpose and patterned after Parker (1973), this study was initiated in a high elevation stand of lodgepole pine in 1972.

The study area was located in a remote lodgepole pine stand in Yellowstone National Park (Figure 1). A stand in the Park was selected to avoid the direct influence of timber cutting in the study plot. Permanent sample plots were established in a 320 acre area of lodgepole pine sawtimber. The stand was generally slow growing with rot fungi and dwarf mistletoe very common. Pole-size reproduction occurred in thickets, but most was suppressed.

The mountain pine beetle infestation in the study area is part of an extensive outbreak in Yellowstone National Park and the adjoining National Forests. This outbreak began in the late 1950's in the southern portion of the Targhee National Forest and by 1966 had spread into the lower elevation stands in the Park. Recently, the infestation has continued to spread northward into the high elevations on the Madison Plateau and beyond.

METHODS

During the fall of 1972, 32 permanent strip plots (½ x 10 chains) were established in a systematic design. Mountain pine beetle-caused mortality was recorded by diameter and tallied in one of three categories:

1. Currently infested trees (1972 attacks).

2. "Faders" (1971 attacks).

3. Previous mortality (1970 and before).

Only trees larger than 5.5 inches dbh were recorded. Also, during the initial survey, a variable radius plot (BAF 10) was established in the center of each strip plot to record green stand data. Each fall following the initial cruise, each strip plot was revisited to record the number of new attacks (1973, 74, etc) and to confirm the condition of attacked trees from prior years. When mistakes were found, tree tallies for that year would be corrected. This technique of yearly surveys and rechecks provided an accurate count of trees killed by the mountain pine beetle during each year of the infestation.

RESULTS AND DISCUSSION

Green stand structure and species composition in the study area before the mountain pine beetle outbreak was reconstructed using green stand and mortality data from the original survey. The stand was predominantly lodgepole pine (116.0 trees/acre) with some subalpine fir (9.7 trees/acre) and whitebark pine (4.6 trees/acre), and a small amount of Engelmann spruce (0.5 trees/acre). Green stand structure and composition are tabulated by one inch diameter classes in Table 1.

Cumulative mountain pine beetle-caused mortality during the infestation was 7.01 trees per acre. This represents a 5.4 percent loss in stems per acre. Lodgepole pine experienced the greatest loss with 6.3 trees per acre killed while only 0.7 whitebark pine were killed. The yearly trend of mortality during the infestation is summarized below:

Year	Lodgepole pine 1/	Whitebark pine 1/
1970	0.38	--
1971	2.01	0.36
1972	1.77	0.18
1973	1.20	0.12
1974	0.74	0.06
1975	0.19	--
	6.29	0.72

1/ Mortality trend by diameter class is summarized in Tables 2 and 3.

Peak tree killing of both host species occurred in 1971, the second year of the infestation. Following the peak, mortality declined each year until the infestation subsided.

Comparing the results reported in the southwest corner of the Park (Parker 1973) and those from this study, several differences are apparent. Susceptibility to, and resultant bark beetle-caused mortality between these two stands, was altered by a combination of physical differences. The most obvious and important difference was elevation, but also included are stand composition and structure, and stocking (Figure 2 and 3). Site may be an important factor in degree of stand mortality, for during a given year of infestation, the taller trees produce more mountain pine beetle brood than do shorter trees of the same diameter or age (Klein, et. al., 1976). At this high elevation, the trees are slow growing and of low form class. One other factor which had a large effect on the low elevation stand and not on the high elevation stand was the large bark beetle populations at the lower elevation. As a result, mortality during this study, was seven trees per acre which was far below the 56 trees per acre measured by Parker (Figure 4).

Residual green stand following this study was 95 percent of the original while only 74% survived at the lower elevation. Amman and others (1973) reported a similar relationship between elevation and mortality in Utah. At the lower elevation peak mortality occurred two years earlier than at the higher elevation.

Although these stands and results differed in many respects, the mountain pine beetle killed a greater proportion of the large diameter trees in both stands (Figures 2 and 3). Bark beetle losses are typically of this type and as a result most of the volume killed is above the commercial threshold. However, other impacts may not all be negative; water yield, and forage capacity, for example, would probably increase.

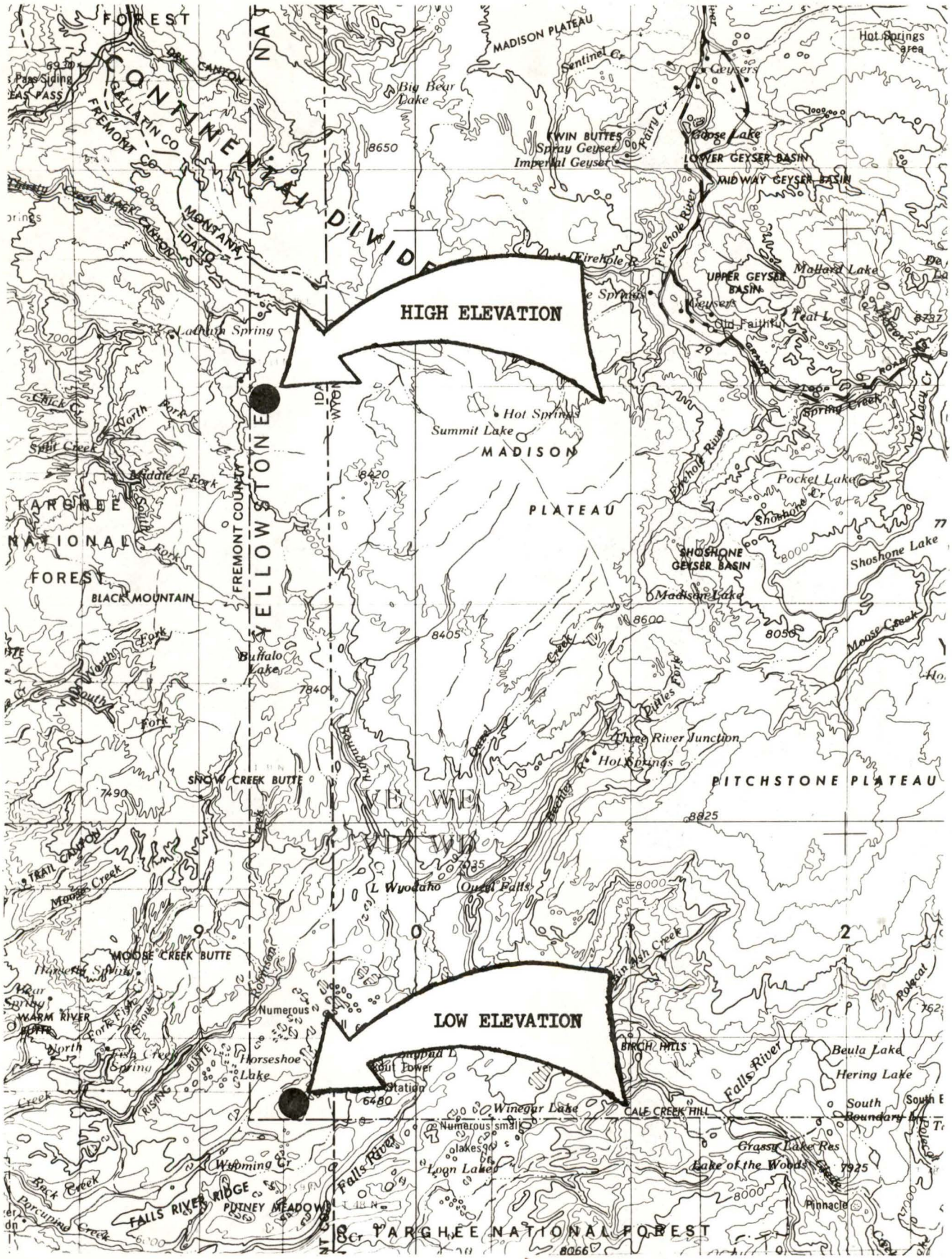
REFERENCES

Amman, Gene D., Bruce H. Baker, and Lawrence E. Stipe. 1973. Lodgepole pine losses to mountain pine beetle related to elevation. USDA For. Serv. Res. Note INT-171, 8 p., illus.

Klein, William H., Douglas L. Parker and Chester E. Jenses. 1976. Attack, emergence and stand depletion trends of the mountain pine beetle, Endroctonus ponderosae Hopkins. During An Epidemic. In manuscript.

Parker, Douglas L. 1973. Trend of a mountain pine beetle outbreak. J. Forestry. 71 (11):668-670.

APPENDIX


HIGH ELEVATION
LOW ELEVATION
YELLOWSTONE NATIONAL PARK
CONTINENTAL DIVIDE
MADISON PLATEAU
PITCHSTONE PLATEAU
TARGHEE NATIONAL FOREST
FOREST
Hot Springs area
Big Bear Lake
Sentinel Cr.
Geysers
KWIN BUTTES
Spray Geyser
Imperial Geyser
Goose Lake
LOWER GEYSER BASIN
MIDWAY GEYSER BASIN
Firehole River
UPPER GEYSER BASIN
Mallard Lake
Old Faithful
Lodgepole
Spring Creek
Lathum Spring
Hot Springs
Summit Lake
MADISON
PLATEAU
Pocket Lake
SHOSHONE GEYSER BASIN
Shoshone Lake
Madison Lake
Moose Creek
BLACK MOUNTAIN
Buffalo Lake
Three River Junction
Hot Springs
SNOW CREEK BUTTE
L Wyodaho
Outlet Falls
MOOSE CREEK BUTTE
WARM RIVER BUTTE
Numerous
Horseshoe Lake
Lookout Tower
Station
6480
Wineour Lake
Numerous small lakes
Logan Lakes
Wyoming Cr
FALLS RIVER RIDGE
PUTNEY MEADOW
BIRCH HILLS
CALF CREEK HILL
Falls River
Beula Lake
Hering Lake
Grassy Lake Res
Lake of the Woods
Pinnacle
Boundary Creek
Bechler R
Dry Canton
Gallatin Co
Fremont Co
Montana
Idaho
Pass Siding
Teat L
Spring Creek
De Lacy Cr
Shoshone Cr
Pitchstone Plateau
Rainbow Creek
Rocky Creek
Chick Cr
North Fork
Split Creek
Middle Fork
South Fork
Trail Canyon
Rising Butte
Back Creek
Porcupine Creek
Rainbow Creek
Rabbit Creek
Bechler River
Dillies Fork
Rainbow Creek
Rainbow Creek
Rainbow Creek

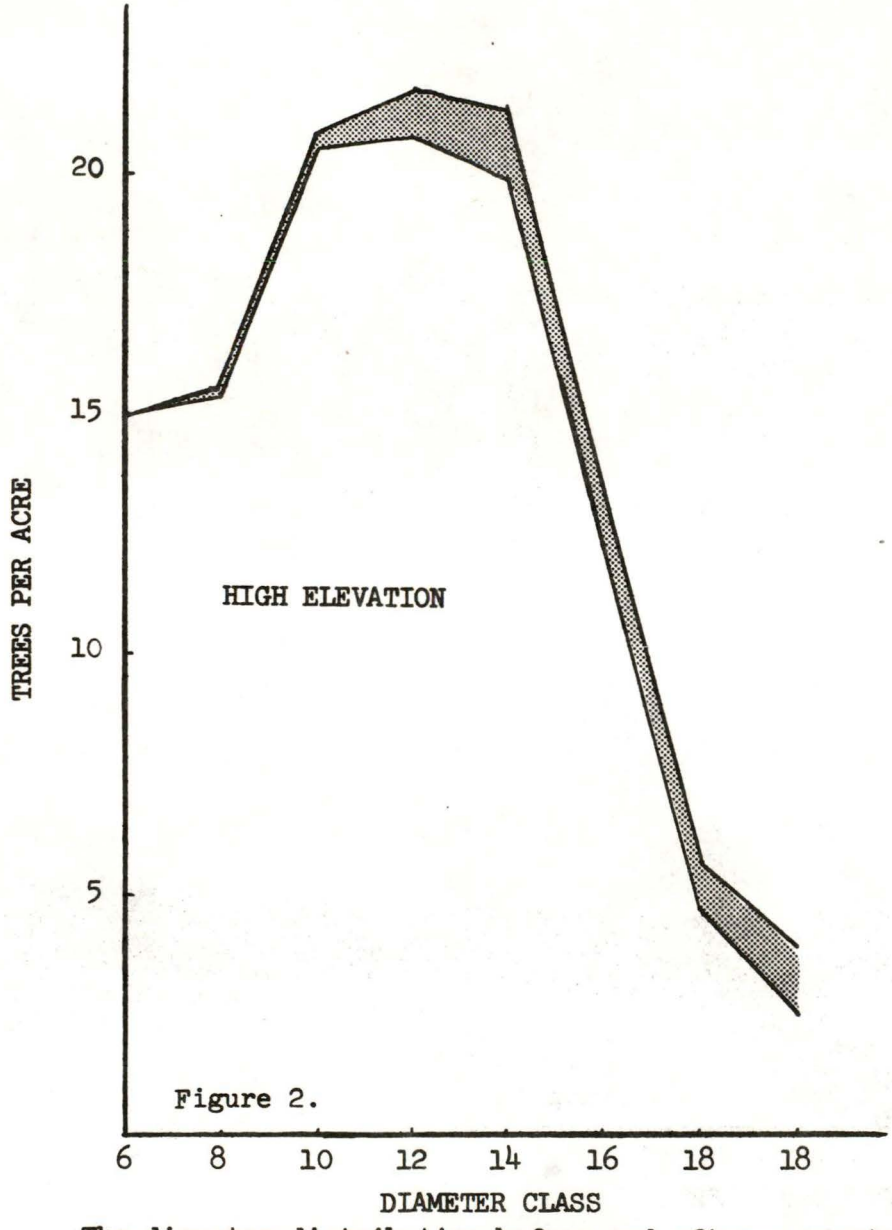


Figure 2.

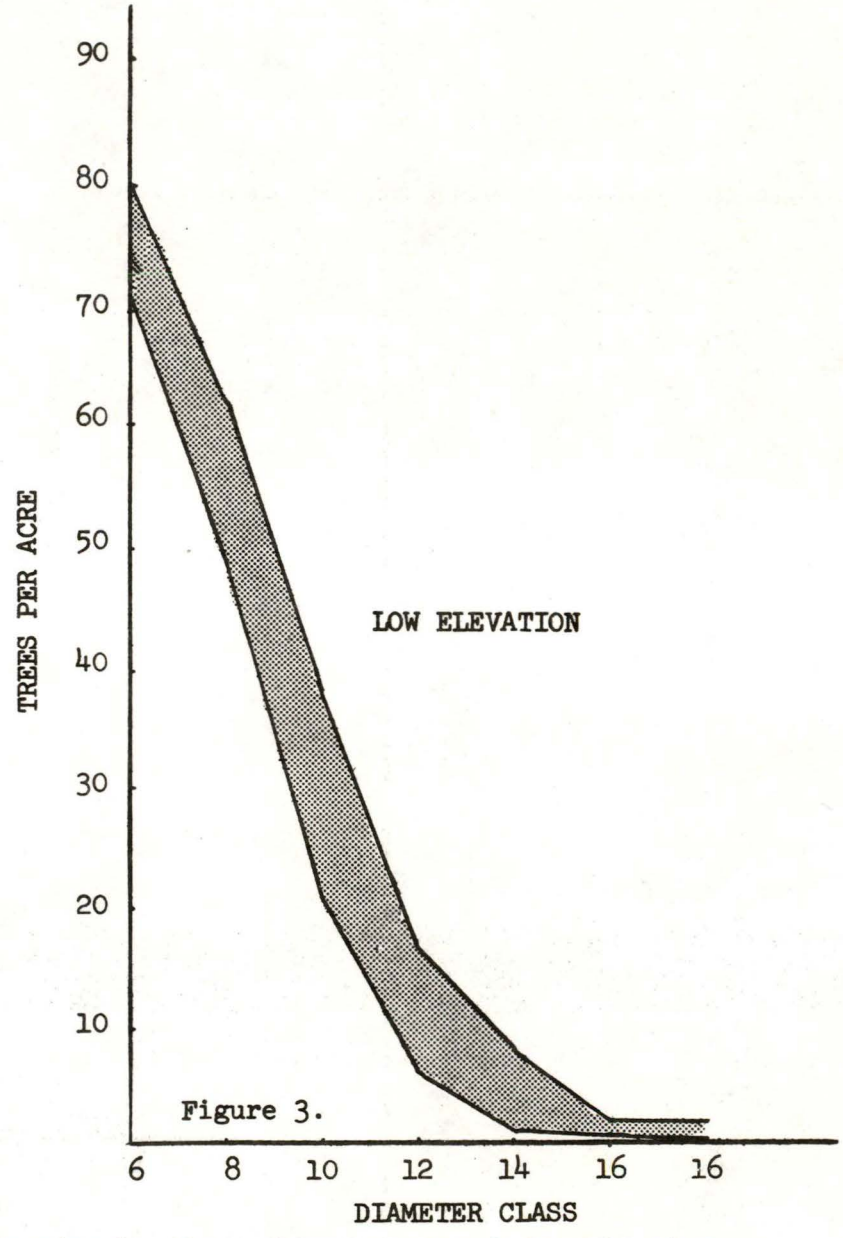


Figure 3.

The diameter distribution before and after a mountain pine beetle outbreak in two lodgepole pine stands in Yellowstone National Park. The shaded area represents mortality during the outbreak.

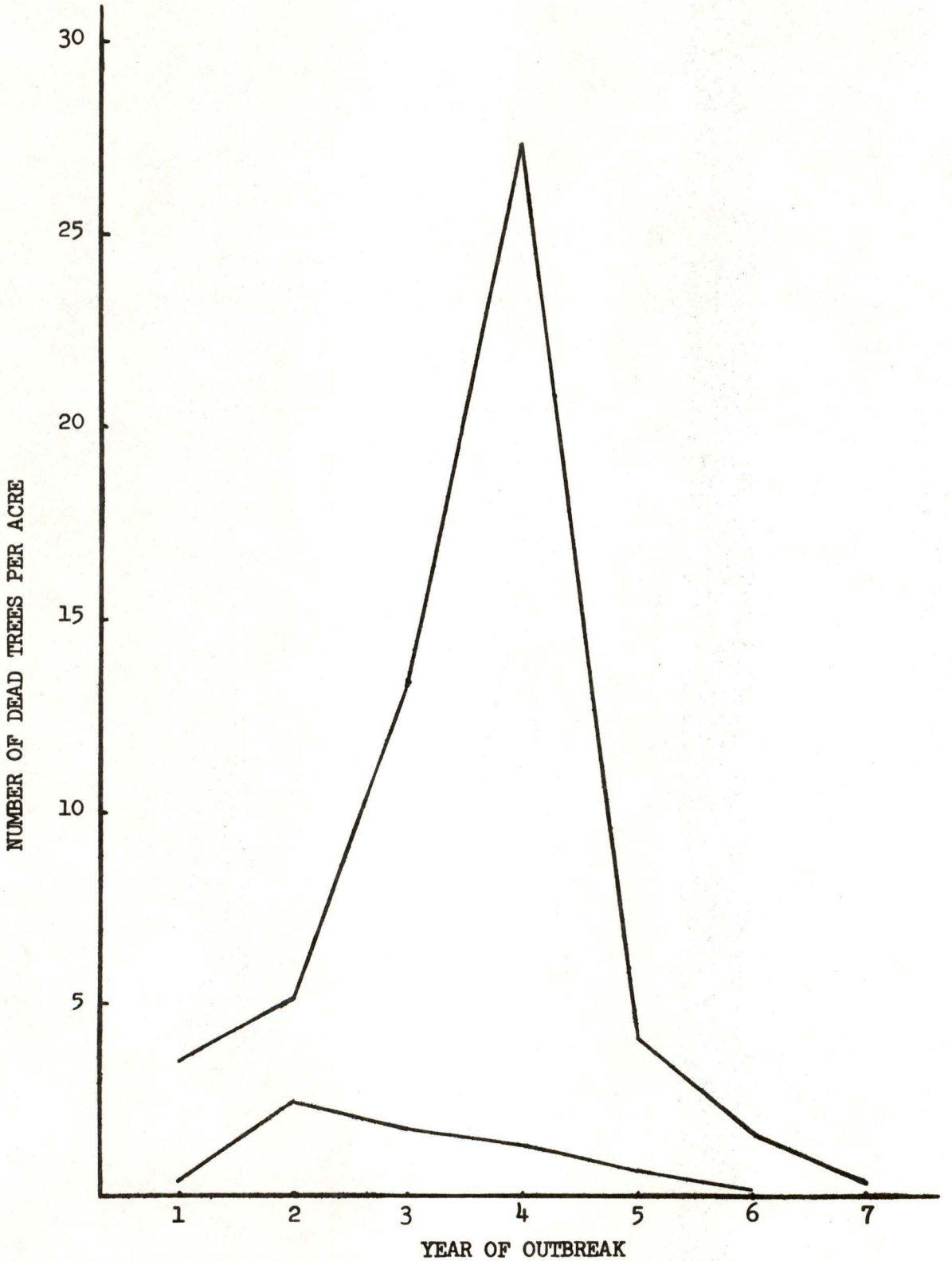


Figure 4. Yearly trend of mountain pine beetle caused mortality of lodgepole pine in two separate stands in Yellowstone National Park. Red line represents the high elevation (8300 feet) and the green line represents the low elevation (6400 feet).

Green Stems Per Acre					
Diameter Class	Lodgepole Pine	Whitebark Pine	Subalpine Fir	Engelmann Spruce	
6	7.96	1.59	3.18		
7	7.02	--	1.17		
8	7.22	--	.90		
9	8.55	--	.71		
10	9.74	--	--		
11	11.02	.47	.95		
12	11.33	.46	.40		
13	10.42	--	1.02		
14	9.54	.95	.59		
15	11.71	.32	--		
16	6.52	.12	.22		
17	6.17	--	--		
18	3.40	.06	--		
19	1.46	.06	.16		
20	1.83	.14	.29		
21	.78	--	--		
22	.24	.18	.12		
23	.35	.06		.11	
24	.59	--		--	
25	.06	--		--	
26	--	.09		.09	
27	--	--		--	
28	.06	--		--	
29	.07	--		.07	
30		--		--	
31		--		--	
32		--		.06	
33		.05		.05	
34				--	
35				.05	
36				--	
37				.04	Total
Total	116.04	4.55	9.71	0.47	130.77

Table 1. Green stand structure and composition in the survey area before the mountain pine beetle infestation in a high elevation stand in Yellowstone National Park.

Diameter Class	Dead Lodgepole Pine Per Acre						
	Year of Attack						
	1970	1971	1972	1973	1974	1975	Cumulative
8			.06				.06
9			.06				.06
10			--				--
11			.13	.06			.19
12		.13	.06	.06	.13		.38
13	.06	.06	.13	.06	.06	.13	.50
14	--	--	.19	.13	.06	--	.38
15	--	.50	--	.13	.25	--	.88
16	--	.19	.06	.25	.06	--	.56
17	.13	.50	.19	--	.06	--	.88
18	.13	.13	.13	.13	.06	--	.58
19	--	--	.19	.19	.06	--	.44
20	.06	.06	.13	.13		--	.38
21		.13	.13	--		.06	.32
22		.06	.06	--			.12
23		.13	--	--			.13
24		.06	.13	--			.19
25		--	.06	--			.06
26		--	--	--			--
27		--	--	--			--
28		.06	.06	--			.12
33				.06			.06
TOTAL	0.38	2.01	1.77	1.20	0.74	0.19	6.29

Table 2. Mountain pine beetle caused mortality of lodgepole pine by year and diameter class in a high elevation stand in Yellowstone National Park.

Dead Whitebark Pine Per Acre							
	Year of Attack						
Diameter Class	1970	1971	1972	1973	1974	1975	Cumulative
8							
9							
10							
11							
12	N	.06				N	.06
13		--					--
14	O	--	.06		.06	O	.12
15		--	.06				.06
16	N	.06	.06	.06		N	.18
17		.06		--			.06
18	E	.06		--		E	.06
19		--		--			--
20		--		--			--
21		--		.06			.06
22		.06					.06
23		.06					.06
TOTAL	0	.36	.18	.12	.06	0	.72

Table 3. Mountain pine beetle caused mortality of whitebark pine by year and diameter class in a high elevation stand in Yellowstone National Park.